

Novel Technology: High Gravity Cryogenic Miniaturisation (CryoMin) for Bulk CO₂ Separation from Natural Gas

Fadhli Hadana Rahman PETRONAS Research Sdn. Bhd. Radin Suhaib Salihuddin PETRONAS Research Sdn. Bhd. M. Khaidhir A. Hamid PETRONAS Research Sdn. Bhd. Norfaizah A. Manan PETRONAS Research Sdn. Bhd. Norhayati Hashim PETRONAS Research Sdn. Bhd.

Abstract High Gravity Cryogenic Miniaturization (CryoMin) is a novel process intensification technology of conventional Cryogenic Distillation technology. The technology utilizing rotating bed column to separate high CO₂ from natural gas. The rotating bed column will increase flooding limit and also mass transfer coefficient (MTC), due to this the column can operate at higher superficial velocity (without flooding) and reduced its HETP (Height Equivalent Theoretical Plate). This game changer technology will reduce the column diameter and column height, significantly. CryoMin technology will benefit for both offshore platform and onshore plant. Despite the benefit of reduction in size and weight, additional power required for rotational of CryoMin is relatively minimal. Natural gas resources with ultra-high CO₂ content with more than 50% mol are remained undeveloped in South East Asia. This is due to not economically attractive to monetize the field. An innovative total solution is required to overcome this barrier in order to develop ultra-high CO₂ gas fields. It is not as simple as developing other green fields, the challenge is more on separation technology, power requirement, weight and space reduction, in order to meet project economics. CryoMin prototype was tested for high CO₂ content (50 to 80% mol) at high pressure (up to 50 bar). Feed flow rate is varied from 1 to 3 Kg/hr and consists of binary component of C₁ and CO₂. The feed gas is cooled down by a pre-cooler before entering CryoMin column. It is a rotating packed column type with adjustable rotating speed (up to 1000 rpm). In-line Gas Chromatography (GC) is used to monitor the product specification at feed inlet, the top product (after condenser) and also for bottom product (after reboiler). The results showed that CryoMin technology can separate bulk CO₂ down to 20% mol at top product stream and the methane loss (C₁) at the bottom liquid product consist of lower than 2% mol. Separation performance were in-line with thermodynamic VLE prediction and validated with GC data. Motor reliability test was conducted for more than 30 hrs non-stop. Vibration test results is within acceptable range. High gravity CryoMin technology is proven for bulk CO₂ separation with targeted specification down to 20% mol at top product. The technology is ready for up-scaling and testing for other contaminants